SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Royal School of Mines, Jermyn-street.

Mr. WARINGTON SMYTH'S LECTURES ON MINING.

Nov. 26.—Mr. Smyth, in continuation, proceeded to consider deposits of minerals under aspects which justified the description of irregular. Repositories of ore of this character might be placed under several different divisions, arising out of the different classes of rock in which they occurred. These deposits were of great importance, as it was from them that in certain countries the chief supplies of iron, copper, and zinc were obtained. They were more intimately related to the geological features of a district than the lodes themselves, because it would be found they were limited in occurrence to one or other of several classes of rocks. These orey masses might be arranged in four different groups. In the first, the productiveness would be found more or less to follow the contact of two different rocks; as, for example, at the contact of greenstone and limestone, or porphyry and clay-schist. Secondly, metalliferous deposits would be found encased in igneous or crystalline rocks—such, for instance, as porphyry. Thirdly, they would be found associated with stratified rocks, whether metamorphic or in their original condition. And, lastly, they would be found to occur in limestone. This was a very general classification, but whatever variations from it some districts might furnish, it was observable that there is a great relation between the mineral repositories and the rocks themselves which contain them. The greater part of these irregular deposits were distinguished from lodes by their mineral contents being less highly crystalline than those of lodes—or, rather, the crystals are of a much smaller and more irregular character. The famous magnetic iron ores of Sweden and Norway are samples of this. The mines in those countries are of great importance, from the excellent character of ore contained in them; and it is noticeable that the deposits there are contained in rocks partly of a crystalline and partly of an ancient schistose character, such as hornblendic and gneissic rocks, associated with garnets, with epidote, augite, pargasite, &c. When these are found plentifully the ore is often very rich. A remarkable instance of the necessity of distinguishing these from bedded deposits and lodes was furnished by the Fawnog Mine, in Flintshire, where there was a partially continuous deposit of lead ore at the junction of limestone and sandstone. Very important deposits of iron ore are also found in the Harz, following the junction of the greenstone and limestone. Some of the most remarkable of the ores contained in crystalline rocks are those of the stockworks in Bohemia and Saxony, which are worked for tin. In the neighbourhood of Schlaggenwald, a locality celebrated for the minerals associated with tin, a sort of underground hill of granite is met with in the gneiss, and this granite is crossed in all directions with minute veins of tin, there being sufficient throughout the entire mass to make it worth working by stamping. They are called **stockworks all along** the district of the Erzgeberge, Altenberg, &c., because they are worked in a succession of stages or "stocks," as it is in the German language. On each of these storeys levels are driven in and chambers opened overhead, till the roof between each two storeys is as thin as is consistent with safety. At Zinnewald, and in Transylvania, at the gold mines of Verespatok, there were workings of this kind; but there was nothing like it in England, except at St. Austell, in Cornwall, where there is a vast opencast formed on the hill of Carclaze, and great masses of material removed, yielding partly china-clay and partly tin. There were curious deposits of this irregular character near St. Ives, termed carbonas (where tin ore in a high condition of purity was found, not in the lodes, but near them), which were discovered by mere chance, being shut in on all sides by great masses of rock. The clue was an excessively slight fissure, which gave out a small quantity of water, which was an indication the miners thought it wise to follow. Similar irregular deposits are found in the metamorphic rocks in Scandinavia, at Fahlun, in Sweden, and at Dannemera; as also at Arendal, in Norway, where exceedingly valuable iron is obtained. He had had the advantage of studying those of Arendal, and the deposits there were found in the midst of schists of extreme hardness; hornblende schist and mica schist alternating. When the miners come to a place where garnets begin to appear in the hornblende they then find lenticular deposits, which consist, to a great extent, of magnificent magnetic iron ore, from 10 to 40 ft. broad, and holding downwards to a great depth. At Arendal the mines are worked to near 130 fms. in depth, and the length of the deposit there is considerable. In most cases they are seen within much shorter limits than a lode to wedge out to a point, and this lenticularity is the characteristic form of these deposits.

At Arendal the valuable magnetite is coupled with other substances, which make it difficult to get, as they are of a metamorphic character, the entire masses of rock being extensively changed since they were first deposited, and rendered more hard and crystalline by chemical action. The celebrated copper mine of Monte Catini, in Tuscany, for its extent one of the most profitable in Europe, was a remarkable instance of the highly productive character of the rock called serpentine. Serpentine is largely developed in the North of Italy, parts of Greece, in Turkey, and the Levant. It here runs like a large tongue into a schistose rock, having appearances of a metamorphose character, and called by the Italians "*gabbro rossa*." The harder serpentine is separated from the gabbro by a portion of a soft talcose soapy nature, against which is a line of an extremely rich copper ore, mostly bornite, or "horse-flesh" ore. The hard serpentine below is comparatively unproductive; it is the softer kind which yields such very rich results. The horizontal extension of that mine is only about 600 fms., and its depth about 100 fms., but it has been for many years extremely productive; and when it is considered that it is situated in ground not hard to work, the profits must have been immense. The most remarkable irregular deposit of this imbedded kind in Europe is, however, that of the Rammelsberg, in the Harz. It is on the slope of a hill composed of clay-slate, dipping at a moderate angle, and is 1800 ft. in length, and 350 ft. at its greatest breadth: at 400 ft. below the surface the vein-mass begins to bifurcate, but presenting still a vast mass of sulphurets formed in a body of hornstone and other hard varieties of quartz. The mine is worked by running out galleries, and breaking the rock by setting fire to piles of firwood fagots artistically arranged. No fewer than 15 metals and 21 elementary substances are obtained in the Rammelsberg Mine. Passing on to what was very important in England as well as on the Continent, he proceeded to notice the metalliferous products which are found in connection with limestone, putting it generally, and without specifying any particular kind of limestone: and drew attention to a large diagram of the Mine of Fawnog, in Flintshire. In this case a number of *shodes*, or fragments of lead ore, were found on the surface, and the lode from which they came was supposed to be near. Many shafts were sunk without success, until at length the patience of the adventurers was rewarded by the discovery of an extraordinary quantity of rich galena and massive carbonate of lead. This singularly-formed mass of ore was not a vein or a bed, but must have been introduced into the cavity it fills after the walls of limestone, and of the sandstone above it, had been consolidated. The lecturer then referred to the iron ores of the Forest of Dean, and the hematite of Cumberland and North Lancashire, which was always found in the mountain limestone, but frequently in proximity to the red sandstone of the Permian formation, and having appearances which indicate its origin to be more modern than that of the limestone. At Park and at Roanhead (which was extremely well worked by Mr. Kennedy, formerly a student in that College), there seemed to be a chasm filled with ore varying from 40 feet to 200 feet from side to side. The space was filled in with a soft ore, interspersed with what was called "kidney ore," and large fragments of limestone from the walls. Similar deposits were largely worked at Cleator Moor. In the Greenwich Hospital lands at Aldstone Moor, and in Swaledale, in the neighbourhood of Richmond, in Yorkshire, irregular deposits of lead ore took the form of parallel layers, or "flats" as they are termed, and produced beautiful crystalline galena; sometimes ramifying from the lode, but often without anything like a vein either over or under. The lecturer also briefly indicated the nature of other limestone ore-depositories, especially mentioning the calamine found in fissures between the carboniferous limestone and shale worked so successfully by the Vieille Montagne Company, whose spelter had secured the upper hand in the zinc trade of the world.

Nov. 27.—Passing away from what might be called the natural history character of different repositories in which minerals are found, the lecturer went on to consider the various methods of search now in use, such as costeaning in Cornwall, or prospecting, as it is called in California and Australia. So much money was often expended in these preliminary operations, and so much ingenuity displayed by those who professed to understand the matter, that it was necessary to be very careful. With all the knowledge and skill said to have been acquired, it was still a fact that most of the discoveries of a profitable nature had been the result of mere accident. If we look to the history of those mines which can be traced back to a distant period, there is little or no evidence about their discovery. Those of which we know the history have often been found by the most simple means. Thus, boys out fishing sometimes find stones containing ore in the brook or on the bank side, which leads to a search being made. A very promising mine in the Plynlimmon district was discovered the other day in this manner. In other cases the ploughshare goes rather deeper than usual, and turns up stones containing ore or gossan. The famous quicksilver mines of Idria, in Carniola, were discovered by a shepherd boy, who put a bowl under a slight rill of water, and was surprised to find, when it was full, that it was unusually heavy, and on pouring off the water, found at the bottom a metallic deposit, which, on being taken to one of the learned men of the day, was pronounced to be mercury. The discovery of gold in California arose from the presence of grains of that metal being observed in digging a new mill-race. That was in 1848, and although it was kept quiet for a time, it led to the pouring forth of such a vast stream of adventurers, that they before long flowed over into Australia and other countries, and produced all those discoveries of gold which have made this age so remarkable. In considering the means to be adopted for a search after metal ores, he was compelled slightly to trench upon the kindred science of geology. No one need attempt to search after the stratified minerals without a practical knowledge of geology; but there are a few points which do not come within the range of general geology, but are the result simply of special practical observation. For example, when the surface is occupied by a thick, cold clay, more or less hostile to vegetation, the miners tell you, and with partial truth, that it is likely to be a coal country; but, after all, there must be the preliminary fact that it is upon the coal measures, as such clays often exist where there is not the slightest possibility of finding coal. Again, the presence of ironstone with limestone is considered a favourable sign; but, as every geologist will explain, two or three kinds of rocks may co-exist, while the fourth, from which the value is to be obtained, may be wanting. It is sometimes pointed out that coal is likely to occur where there are surface deposits of a ferruginous character from springs of water; and as long as you are in a coal district that is, no doubt, a good sign. But it has commonly been noticed that a flow of water, with a film of an iridescent colour, produces a deposit of brown ochreous iron, like the valuable bog and lake iron ore. But why is that the case? Simply because the iron-bearing mineral is decomposed, and the water becomes impregnated with sulphate of iron, which becomes oxidised, and yields ochre. Iron pyrites is contained plentifully in both the older and newer formations, and, therefore, is frequently found when it has not the slightest connection with coal. Even within the coal measures themselves there are certain signs or symptoms which, however promising, are not to be trusted at all. Thus, coal may always be found to repose on floors more or less indented with rootlets of stigmaria, and the indication may prove very valuable; but stigmaria clay may also exist without the coal. Again, salt springs are looked upon as guides to rock-salt, and sometimes are themselves more valuable than the rock-salt itself, which may be far distant; and fragments of asphaltum at the surface do not always indicate beds of that material. Again, gaseous emanations are thought to indicate deposits of coal; but it has been proved that they may be given off in large quantities by the shale, or from very thin seams of coal, not worth working. Gaseous emanations, however, do sometimes lead to right conclusions; as, for instance, in Nova Scotia, where they are common in some streams, and so abundant as to burn on the surface of the water, and where the coal measures have been found to extend beneath those rivers. Near Walsall there is a remarkable emanation of this kind, where a public-house is lighted by merely digging a hole in the cellar, and putting a pipe into the opening, in which case there is no doubt but that the gas oozes up through the sand and gravel from the coal measures beneath. It is a common fact that these emanations of fire-damp are sometimes given off by beds of rock salt, as in the salt mines at Bex, and at Wieliczka, and in China, where the gas is used to light the levels for the workmen; and some contend that this phenomenon is no doubt due to the presence of coal beneath the salt. Passing, however, to the various problems to be solved before beginning mining operations, there were three objects which he presented to them—First, they might have to determine the position of the back, or outcrop, of the lode they felt inclined to work; secondly, to discover branches or parallel lodes in the neighbourhood; and, thirdly, the exploration of new ground. In the two first cases they would have data from which to draw conclusions. When the lode is enclosed on both sides by the same rocks the true bearing and direction must be taken. This could only be done by opening a good length of ground, as it might sometimes run a distance before it changed. Next, it must be ascertained whether the lode is perpendicular or inclined, and, if inclined, at what angle; and for this purpose the cautious miner would be careful, as it might be deflected from its course in a few feet or in a few hundred yards; or if a valley intervened there might be some difficulty. In dealing with a district where there are old mines the utmost caution is necessary, as such enormous amounts of money have been spent in the resumption of old workings with so little result. The first thing to do was to ascertain if any statistics are obtainable of the old workings. This seldom happens, as many of these mines have been abandoned for 30, 40, or, perhaps, 100 years, or more. If, however, its date is more modern, it is most important, if possible, to get a plan of the mine, and when it was abandoned, with a section, so as to get a notion of the value of the different veins or beds, the expense of working different parts, and the price of metals at that time. In no country more than England has mining been successfully carried on for a long period, and in no country has there been such a general neglect of the preservation of plans and documents of this kind. When there is no documentary evidence that can be obtained, that of the oldest inhabitants who remember the working should be sought for. This, however, must be received with great caution, for probably, with no intention of misleading, such people are apt to remember with distinctness the most promising features, and to forget the others. They often tell tales of much ore being left in the bottom of the mine, whereas, when search is made, very little is found. Then, again, we may have to deal with mines that have been abandoned for thousands of years, as the ancients were great miners in their way for copper, tin, and other metals; and in such cases the attempt will be naturally attended with a series of difficulties. There is often nothing to be seen but a number of heaps in a row, with slight hollows between them, but probably of a much less depth than might be supposed if we conceived them to have been shafts, as the action of the atmosphere and the operations of agriculture have a rapid tendency to reduce inequalities of this kind. If, however, one of these old shafts should be open it will give greater facilities for seeing something of the vein itself, and its direction. There are many points in the old men's workings to be taken notice of. The first thing would be to find out what sort of means of working those who made these old shafts were possessed of, and the nature of the material brought up by them. If in digging over the surface you came to stones in the burrow you would be able to tell in a moment whether they belonged to a vein or not; and, if they did, it would be a question whether there were any reasonable appearances of a promising yield, and not only the character of the mineral obtained but the richness of the vein might sometimes be indicated. If the mine had been very rich it would be found that a considerable portion of orey stone would be thrown away, either because in those days they did not know so well how to work with profit the poorer stuff, or that there was so much ore as to make them careless. No doubt we had great advantages now in our improved methods of dressing and smelting ores, and in our superior machinery, and it might, therefore, be worth while now to work a mine which could not be worked before. Again, if a large flow of water is coming out of the adit level then it is probable the old miners have not worked the mine to any great depth; but if there is not a great flow, then it is probable that the reverse is the case. Thus there is room for a good deal of observation and argument, founded on what we see, as to the probabilities of success. Lastly, caution should be brought into play as to the character of the material and ground to be worked. At some places in Cornwall the granite is so soft that you may drive a shovel into it, and when material of this kind occurs it may not be so difficult to excavate as to keep the levels and shafts open. Indeed, it may prove so difficult as to render it necessary to open the same levels and shafts in less dangerous ground. In dealing with ancient mines, it will always be well to attend to the old heaps from smelting-works, which, by a little examination, will show what kind of ore has been worked in the district.

Nov. 29.—Passing from the consideration of modes of search in ground of which we know something, to the circumstances which must guide us in taking up similar works in new ground—that is, where the places at which mining is carried on are few and far between—we must form our first judgment by a series of external appearances. Some practical acquaintance is now needed with the sciences of geology and mineralogy, in order to select the repositories in which the minerals we want are to be found, or we might occupy much time and spend much money on districts where there is no chance of discovering metals. In the case of all those countries in which a correct geological survey has been made the miner is greatly assisted; but there are large tracts of country where much mining is carried on, such as Australia and California, where this is no yet the case. Till, however, we got the geological conditions laid down we work in the dark. In the great mining districts of this country there are now excellent maps, and by a glance at that of Cornwall and Devon (exhibited on the wall) we see at once how the minerals are distributed, what is their character, and when we might with fair probability expect to find tin, copper, lead, antimony, and iron. Taking, however, a district where there are no such advantages, the first thing, as I have said, is to examine the features of the ground, and compare them with what we have seen elsewhere, have read, or can obtain orally. There used to be a strong belief, and indeed it still exists, that we should prefer a district of gently undulating hills to a range of crags and precipices, and mountain ranges of a secondary rather than a principal character. And this is borne out by the fact that in the chief ridge of the Alpine, the Carpathian, and other similar ranges, but little ore-bearing mineral has been found, but in the ranges subsidary to them, and in the more gently undulating surfaces below that, the greatest yield of metalliferous deposits is found. Again, some will prefer, and expect greater riches on a particular side of a hill. If it runs east and west they prefer the sun side, and certainly examples may be pointed to, as near St. Day's, in Cornwall, where this preference is amply justified by the results at the Great Consols and United Mines. It cannot, however, be laid down as a general rule. When miners are looking for stratified deposits, as coal or ironstone, they endeavour to get hold of ground free from faults or disturbances, while the nature of metallic mining renders it necessary to go into districts where these quondam disturbances do exist. The question of geographical distribution is a difficult one, respecting which our information is insufficient; but there are a few facts which may be noted. It was formerly thought that it was useless to expect gold in high latitudes, but of late years the finest yield of gold has been from California and the Siberian side of the Ural Mountains, proving that that metal is not limited to any particular latitude. We have already seen that the direction and inclination have influence in the productiveness of metals, but it will always be found that when two series of veins exist in a country—the one running east and west, and the other running north and south—they will produce quite a different class of minerals. Even in the Isle of Man, where it happens that both series of veins are highly productive of lead, the veins are of a different character. This is also observed at Seigen, in Germany, with respect to iron ore; but the veins from east to west are regular, and those from north to south extremely irregular. Again, some miners prefer lodes which dip to the south, but there are probably as many dipping the other way which are equally valuable. In some localities great stress is laid upon having lodes which dip with the hill; but, on the other hand, the dip under the hill is often preferred, there being an idea that the more cover the lode has the better developed it will be found to be. Burr, in his little book on geology, pays great attention to these points, and gives many illustrations. Amongst other signs, there are some which at first appear a little improbable, such as that the snow melts sooner in winter, and that the grass ripens soonest in summer, over the back of a lode; and, no doubt, in many instances there are good chemical reasons why this should take place when the lodes make up close to the surface. It has been thought that botany might prove a great assistance, as certain plants or trees grow only near certain metals, but I am not prepared to agree with this doctrine. It is true that certain plants are known to go with salt-bearing deposits; and it has been stated to me by an eminent Indian officer that it was very remarkable that in Central India a certain class of flora, which abounded on the coast, disappeared as he travelled into the interior, and reappeared hundreds of miles off, in the Scinde district where salt is capable of being largely worked, and where it crops out at the surface. It has been said in a certain iron district that the lodes are indicated by yews; but it is more probable that cuttings of that tree have been used to mark out boundaries, and have been left, and grown to trees. There are one or two points which ought not to be omitted, but on which I cannot speak from my own experience. It is stated in old books, and affirmed by men now living, that lambent lights have been seen at night over the lodes; and these accounts are not confined to one district, but the same thing is affirmed in Germany, in Bohemia, in America, and elsewhere. It was positively stated by the late Davies Gilbert, President of the Royal Society, that he had seen this phenomenon with his own eyes in Cornwall. Many Cornish mine captains have stated the same, and add that where the vein is worked out it is no longer seen. It rests upon such high authority that it is difficult to disbelieve it altogether, and, perhaps, it may be accounted for in districts where the phosphates have been proved to occur in large quantities. Another sort of indicator, less common now than formerly, is that of the divining-rod, the belief in which was widely spread in the twelfth and thirteenth centuries, when it was in high repute as a means not only of discovering metals but water-springs. Several of the oldest continental mines were said to have been discovered by this means. It was said, however, in those days that it savoured of the black art, and was set down as unlawful. It has now fallen into disrepute, except in a few districts; but only a few years ago a French ecclesiastic realised large sums by professing to find springs of water by the divining rod. The lecturer then produced one of these rods, composed of a forked branch of hazel a year old, and described the mode in which it was used. The diviner or dowser with this rod in his hands, held in a peculiar manner, walked over the ground, and when he passed over a lode or a spring the end of the rod bent, as it was stated, towards the spot. An interesting book on the divining rod had a few years ago been published by M. Chevreuil, of the French Academy. One of the best means of ascertaining the nature of the minerals in a new country is to carefully examine the river beds, and see what kind of stones are brought down by the stream. You will recognise at once such as belong to metalliferous repositaries, such as fluor-spar, sulphate of baryta, to say nothing of fragments of the ores themselves. The stream must then be followed upwards, and if any branch runs into it examination must be made, whether the stones came down that branch or from a spot yet higher up. Sometimes indications are found of gold and tin by washing or panning. When the neighbourhood of the lode is reached, as indicated by the disappearance of the shode stones, it may not then be easily discernable, as it may be covered up with soil, gravel, or other material, and then it will be necessary to make use of the process called "costeaning." If the run of the vein is supposed to be east and west, then the costeaning trenches should be cut north and south, and in this way the whole of a considerable space may be thoroughly searched until the vein is intersected. A species of costeaning called "hushing" is practised in districts where the surface has but little agricultural value. A dam is made, and the rains collected until there is a good head of water. This is then let out by a trench in the direction required, and by its velocity it washes out a vast quantity of material and often lays bare the hard rock. The material brought down is carefully searched for shode stones, and veins have not unfrequently been discovered in this way. The lecturer illustrated his remarks by a variety of maps and diagrams, and at the close of his discourse the students examined, with great interest, the divining rod.

The Institution of Civil Engineers.—At the meeting of the members, on Tuesday (Mr. C. H. Gregory, Vice-President, in the chair), thirty candidates were balloted for, and declared duly elected, including six members: Mr. Peter Ashcroft, chief engineer to the South-Eastern Railway Company; Mr. John Chester Craven, locomotive superintendent of the London, Brighton, and South Coast Railway; Mr. William Johnstone, engineer to the Glasgow and South-Western, and other railway companies; Mr. Thomas Martin, A.B., executive engineer, Bengal establishment; Mr. James Raine Rushton, chief resident engineer of the Great Indian Peninsula Railway; and Mr. Arthur Anderson West, first-class engineer on the Great Indian Peninsula Railway, and lately in charge of works on the Bhore Ghât Incline; and twenty-six Associates:—Mr. James Abernethy, Ferry Hill Ironworks, Aberdeen; Mr. Thornton Andrews, Gasworks, Swansea; Lieut. John Charles Ardagh, R.E., Newhaven Fort; Mr. Robert Dudley Baxter, Westminster; Mr. James Blackburn, resident engineer of the Droylsden Gasworks; Mr. William Wingfield Bonnin, Florence; Mr. Thomas Brassey, jun., Westminster; Mr. Albert James Leppoc Cappel, superintendent of telegraphs in the Bombay Presidency; Mr. George James Crosbie Dawson, engineer's office, London and North-Western Railway; Mr. George Eedes Eachus, Westminster; Mr. Joseph Breedon Fryer, Westminster; Mr. Thomas William Gardner, Westminster; Lieut. Lewis Conway Gordon, R.E., Vice-Principal of the Thomason Civil Engineering College, Roorkee; Mr. John Thewlis Johnson, Manchester; Mr. William Mercer, recently upon the works for the drainage of the Rio de Janeiro; Mr. Charles James More, late resident

engineer of the Canal Cavour, Italy; Mr. Charles Mumford, Local Board of Health, Wisbeach; Capt. Francis George Shirecliff Parker, H.M.'s 54th Regiment; Mr. Michael Patterson, Stowford Mills and Gasworks, Ivy Bridge; Mr. William Ridley, late of the Mauritius Railways; Mr. Christer Peter Sandberg, engineer on the Swedish Government Railways, Stockholm; Mr. William Brounger Taylor, resident engineer on the Aberystwith and Welsh Coast Railway; Mr. James Farnham Tuson, late a resident engineer on the Ottoman Railway; and Mr. Edward Henry Woods, resident engineer to the Central Argentine Railway Company.

ON THE DEVELOPMENT OF THE IRON TRADE.

The ordinary monthly meeting of the London Association of Foremen Engineers took place in Doctors' Commons, City, on December 1. The attendance was very numerous, and the chair was filled by the President (Mr. JOSEPH NEWTON, of Her Majesty's Mint). The early part of the sitting was devoted to the election of several new members, a consideration of the qualifications of many candidates for association, and in the discussion of certain propositions of the President for extending yet more widely and more practically the advantages of the institution. When these matters were satisfactorily disposed of, Mr. JAMES ROBERTSON, of Roslin Tower, Tooting, proceeded to read the fourth paper in his proposed series of six on the "Development of the Iron Trade," and it was, as will be seen, especially confined to the railway period. We feel pleasure in publishing the paper *in extenso*, although Mr. Robertson has necessarily travelled over ground which has been partially trodden by others. He said:—

In pursuance of this subject, I touched on the last occasion on which I addressed you the progress of steam navigation, as one of the elements in the development of the iron trade; it was then shown how, in a few years, the tiny boat of Miller, of Dalswinton, had been succeeded by river steamers and ocean-going ships, how the old world and the new had been connected by lines of floating palaces, connecting either hemisphere, traversing every zone, making voyages to the remotest regions of the globe a holiday—such is the luxury and comfort to which the intelligence of man has raised the science of migration—culminating in the greatest triumph of modern times in this direction, that floating citadel, the *Great Eastern*. Since I last addressed you that great ship has accomplished her great achievement, and added a new laurel to the mechanism of this country. The production of the miner's industry, the assiduity of the smith, the science of the engineer, have, by their united efforts, well combined and harmoniously and consistently followed out, united by a cord the two great nations of English-speaking men, united them by a tie fragile in itself, but unseverable in the strength of the sentiment which its union implies, making England and America the Siamese brothers of Europe, separate and distinct in form and being, yet united by that electric filament through which the life-blood of commercial thought and political intelligence surges and reflows; sprung from a common origin, united by identity of interests, language, literature, and sciences, and which if ever severed, save by the rude hand of accident, must be the knell of one or both the nations which that cord unites. Of this great triumph of our iron products we may well be proud, but we have yet to consider and examine how one equally great, one more immediately under our own observation, sprang a little later into being; how another navigation than that of sea rose into existence; how the steam horse, that Pegasus of modern times, acquired his breed and training, and baffled the fleetness of all other steeds whose pedigree was flesh and blood; how a new mode of transit rose to the dignity of a science, a new science, apart from, yet begotten by, those already known; and how we come to recognise a new civiliser of the age in the history of the railway system of England. This subject is vast, and, were I to treat it only in a commercial and statistical point of view, would be dry and uninteresting to the general listener, although it might be attractive to the statician; and did I advocate any particular form of rail or engine, transverse or longitudinal sleepers, outside or inside cylinder construction of fire-box or boiler, it might provoke a discussion which even the well-known judge-like fairness of your Chairman might find it difficult to allay. But this is not my province; it is to well ascertained facts that my remarks must be addressed, leaning to neither, for the historian who writes with a bias to party places even facts (which otherwise pass as undoubted) in question, by reason of the partizanship. The idea of a locomotive engine is by no means new; it dates as far back as 1759 (107 years ago). When James Watt was mathematical instrument maker at the University of Glasgow, there was a student there with whom he formed an acquaintance; that student was afterwards Dr. Robison, and is said to have been the first to suggest the application of the steam-engine to locomotion. His chief work was one on mechanical philosophy, published from his lectures, in 1822. Watt himself acknowledged the doctor's services in his early study of the steam-engine. Oliver Evans, twenty years later, brought out a locomotive which ran in the streets of Philadelphia, but his townsmen thought him mad; this has too often been the public decision on inventors in advance of their age. His first locomotive ran in 1800, in Philadelphia. The origin of railroads, in common with all other mechanical inventions, is to be attributed to our necessities. Accident, or "fortuitous concourse" of circumstances has been the parent of many chemical discoveries, but that prolific parent, necessity, is the ancestor, if not mother, of most of our mechanical discoveries, the railway system included. It was at Newcastle-on-Tyne that railways were first used, or, as they were called, tramways, from the name of Mr. Outram, the latter syllable of whose name was alone pronounced. These were used so early as 1676, for carrying coals from the pit to the banks of the Tyne. The rails were of timber, straight and parallel: clumsy carts, loaded with coals, were drawn by horses over the rails, and so easy was the transit that one horse could draw four or five chaldrons of coals. Timber was more plentiful then than 100 years after, and as the tramways wore out they were replaced, till 1776, when cast-iron tramways were laid down, to obviate the continual replacement required by the wooden tramways under the constantly increasing traffic of the district. As the width of the iron tramway was necessarily limited, an inner flange was cast thereon, to prevent the wheels of the cart sliding off, this primitive mode being the very reverse of the present railway system. A practical objection, however, existed to these tramroads; the small coals from the wagons fell upon the roads, the roads became covered with dust in dry weather, and in wet with mud, and more power was required to move the load. In 1789, Jessop, in order to obviate this objection, transposed the flange from the rail to the wheel, raising the rail sufficiently to clear the ground, and thus permit a uniform traffic under all conditions of weather. This was the first application of the present system of sleepers—sleepers so-called, because the rail rested upon them, but the system was far from perfect; the cast-iron rails broke under a heavy load, greater strength was required, and a fish-bellied rail was next invented, to give support to the rail between sleeper and sleeper, chair and chair. This was the invention of Mr. Birkenshaw, and was the first form of rail used on the Liverpool and Manchester Railway when it was opened, in 1829. The rails weighed 35lbs. per yard, and the chairs were 3 feet apart, fastened down to stone blocks as sleepers. The earliest tramway locomotive was that of Mr. Trevithick; it was to run upon rails, but it was thought that there would not be sufficient grip upon the rail to enable the engine and train to mount a gentle incline, and a system of cogs was applied by Blenkinsop. Trevithick's engine had but one cylinder and a fly-wheel to get the crank over the dead centres. In 1802, Mr. Matthew Murray's carriage on four wheels was so mounted, and was an improvement on Trevithick's locomotive. It is asserted by a good authority that he made the first locomotive that worked regularly on any railway; this he erected for Blenkinsop, for the Middleton Colliery Railway, near Leeds, in 1812, and it ran for many years. In this engine Murray introduced the double cylinder, and dispensed with the fly-wheel of Trevithick's engine. In the same year the Messrs. Chapman brought out an engine, distributing the weight over a larger surface; and about the same time Mr. Brunton, of the Butterley Iron Company, planned a carriage on the walking principle, imitating the movement of the horse's foot. One great difficulty in the locomotive engine was the obtaining a sufficient draught for the furnace; bellows were employed to blow the fire—the introduction of the steam pipe in the funnel was not known.

But whilst the locomotives were being thus improved, another serious difficulty presented itself—that was, the form of rail to be employed. The earliest form of rail was a bar about half an inch thick, spiked down to a longitudinal sleeper. The rails were thus too thin and weak; the pressure of the engine made the bars turn upwards; they sometimes entered the floors of the carriages which ought to have passed over them, and the rails were then called snake's heads, from the unwelcome appearance they presented to the passengers, and the passengers used to speculate on the preference of the lines, and discuss on their journeys as to which presented fewest of those unwelcome visitors. These are the earliest instances of tramway rail locomotives, but a locomotive working on a common road had been invented by a Frenchman at a much earlier date than any of those—viz., in 1769. This was the invention of Nicholas Joseph Cugnot; that experiment having succeeded, a larger engine was made in 1771. That engine still exists, and is to be seen at the Conservatoire des Artset Metiers, at Paris. "It had two cylinder- placed upon a boiler, and having each a steam-tight piston, moved alternately by steam admitted through a four-way cock." The completion of Cugnot's engine was authorised at the expense of the State, and when finished it could carry four persons on a level road at the rate of two miles and a quarter per hour; the boiler was so imperfectly constructed that it could only generate steam enough for a quarter of an hour's run, when it would stop, as if to gather breath, and then make a fresh effort at locomotion. Yet this trial was considered sufficiently satisfactory to justify the State in a large expenditure on another and larger engine, made for work with a good sized copper boiler suspended at one end, and carrying its own fire beneath it, and the flue passing perpendicularly through the boiler. It was engine and train combined, and could carry a load of nearly 5 tons; the front part steered, and was connected with the body of the machine by a swivel pin, and the steering gear was effective as well as simple. The progressive movement was obtained by means of a ratchet wheel on the centre of the driving axle, and the descent of the one piston caused the ascent of the other alternately. "The tyre was roughened to increase the 'bite.'" The weight of this engine, with its load, being about 5 tons, and the speed 2¼ miles per hour on a level road, it would be a 5-horse power engine. This engine was tried only a few times, when it accidentally upset, somewhere near the Madelaine; it was then locked up in the Arsenal, and its career apparently terminated. As creeping is the preliminary to walking, it may not be inapt to say that our express engines have had their childhood and elementary crawl; that this kettle-holding machine indicated, by dragging its slow length along, the future of a much greater speed. But science is slow in comparison with life; her steps, though progressive, gradual, and success often furthest removed when apparently on the point of realisation. That Cugnot's engine lay long neglected cannot be matter of much surprise when we remember the state of political and social opinion in France at that period. Choiseul, Minister of War, under whose direction the experiment had been made, and who believed the locomotive to be adapted to the purposes of his department, fell from power through the intrigues of Madame du Barri, the shameless mistress of Louis XV., and the oppression, injustice, national distress and bankruptcy, which, with other grievances, led to the French revolution, were ripening in the public mind to open revolt and violence, and periods of internal and national revolution are not calculated to make the peaceful arts flourish. Nevertheless, Cugnot was "the first to apply the high-pressure or non-condensing cylinder, with pistons, to the production of rotary motion, and the energy of steam to what is still the principal sphere of animal power, and he certainly established the fact that steam could serve the purposes of horse traction." Although a speed of only 2¼ miles per hour was attained by Cugnot's engine, yet a great victory in locomotion had been achieved, when we consider that the friction on a level railroad is only one-tenth to one-seventh of the friction on an ordinary level road; so that, supposing the same forces to be applied in both cases, it would move a weight from ten to seven times as great on the former as the latter; but if there be an ascent of 1 in 50, which on an ordinary road would hardly be perceived, a great increase of power is required on the railroad to overcome the resistance thus produced, for the load on a level railroad is about seven times as great as on a common road, so that when the force of gravity is brought into operation by an ascending plane, its opposing power being proportioned to the load, is seven times as great as on a common road.

It thus appears that, from the exceptional social condition of France, Cugnot's discovery was laid by unnoticed. But there were other causes why the discovery remained unnoticed; there were no railway companies at that time, or rather no coalescence of commercial men spirited enough to undertake the pecuniary risk and personal anxiety of carrying out the locomotive to its full application, as was afterwards done by the Liverpool and Manchester Railway Company; besides this, the great engineer of the age had discouraged non-condensing high-pressure steam-engines—so did all his contemporaries. Yet this disapproval of high-pressure engines is not so remarkable either, considering that it was on the condensing engine that Watt made his great discovery, and that large as the saving of fuel effected by the use of a separate condenser had been, it was scarcely credible that a further economy could be obtained by the non-condensing locomotive. The consumption of fuel in Watt's best engines was from 6 lbs. to 10 lbs. of coal per horse power per hour, and Watt said that (1786) a locomotive engine would consume 20 lbs. of coal and 2 cubic ft. of water per horse power per hour, a rate about four times over that of our present locomotives. Watt, however, foresaw that multitubular boilers might one day be applied to locomotives, although he feared that such boilers would be very liable to accidents. In 1784, Murdock (Watt's assistant) made a small working model of a locomotive, which was in the Exhibition of 1851, and is still preserved by Messrs. Boulton and Watt, at Soho Works.

In 1813, Mr. Hedley, of the Wylam Colliery and Wagon Way, constructed an engine on Trevithick's plan, one of Blenkinsop's engines having torn up the rails, and the laying down of a strong rack would have involved an outlay of 8000*l*. Hedley's new engine was to obviate this; it had a cast-iron boiler, with a single internal flue, a single cylinder 6 inches diameter, and a fly-wheel, and worked upon smooth rails by attrition of the driving wheels; but it was deficient in evaporating power, and it was clearly seen that a second cylinder was needed. Mr. Blackett therefore commissioned Hedley to construct another engine, with two cylinders, and a return flue through a wrought-iron boiler; the chimney was at the same end as the fire-door; the cylinders were vertical, and the four wheels had their motion communicated to them by toothed gearing. This engine was called the "Grasshopper," from the peculiar construction of the beams with which the piston rods were connected, working several feet over the top of the boiler. Hedley's first locomotive, of 1813, called "Puffing Billy," is now in the South Kensington Museum. The introduction of the blast-pipe into the chimney has been claimed for Hedley, but whether his memory is entitled to that application or not it is certain that in this engine, constructed for the Wylam Railway, in 1815, the waste steam was turned up the chimney, passing in its way thither through a cylindrical reservoir, so as to subdue the noise of its escape if it were allowed to go direct into the chimney; but this appears to have been done by Trevithick, in 1804. It is important to observe that the engines with toothed gearing had no springs, and made much noise, and that they were so light that the driving wheels slipped round upon the rails on the most gentle incline; 6 to 8 tons was the weight, or about one-fifth of the weight of the locomotive of the present day. Then the permanent way had not been improved, as it now is; then the science was in its infancy, but it is not within my province to trace too minutely every footstep of the progress by which the locomotive engine has become "a thing of beauty, and a joy for ever." Those early efforts at steam locomotion had so little, if any, superiority, over traction by horse power, that even so late as 1828 there were grave rumours about abandoning the locomotive altogether, and employing horse power of horse-flesh alone on the tramways of the North. It is a singular fact that up to so late a period as 1829 the locomotive was almost exclusively confined to the traction of coals and merchandise, its adaptability to the conveyance of passengers having been doubted, except by a few of the advanced engineers of that day; but a new era was about to dawn, and a new man was to be the representative of that era—that man was George Stephenson.

Next to tracing the progress of the early struggles and slow development of mechanical science, nothing appears to me more interesting than the biographies of those men by whose steady application, self-denial, and persistency great achievements have been realised. Each inventor is inseparably connected with his path in science, and becomes the exponent of a principle, the apostle of an idea. The locomotive engine as we have it is the result of vast thought, combined and independently, of a great number of gifted men. It did not spring to earth new formed and perfect, as Minerva did from the brain of Jupiter, but has received, and is still the recipient of, the contributions of the intelligence of three generations, and conspicuous amongst the early pioneers in this branch of science stands the memory and improvements of him named above, and to a sketch of whose life I will now direct your attention.

A little cottage between Close House and Wylam, in Northumberland, was the birth place of George Stephenson, not far from Newcastle, that sable California or the North. That event took place on June 9, 1781. His father, Robert Stephenson, was then fireman of the pumping engine at Wylam Colliery, and had a family of six children, George being the second in point of age. This origin was certainly humble enough; but, added to that misfortune of birth, he received no education, but was made cowherd, ploughboy, carter, and had to do whatever was to be done that he could do. At a very early age he was set to work to earn a livelihood, and his first wages were 2d. per day. He had to pick "bats and drops" from the coal, and used to hide himself from the overseer when he took his rounds, lest he might be considered too small a boy for such work. He had thus to labour before he could read and write, and it must be admitted by all that this unpropitious commencement of life augured little of the eminence of its closing years. At the age of 14 he was engaged to assist his father, then fireman at Dewley, and he was shortly afterwards "breaksman" for Waterrow Pit, on the tramway between Wylam and Newburn. It has been facetiously said that it was here he set up his first servant, which was a dog that fetched his dinner daily from Walbottle Colliery to the tramway. His father removed with his family to Killingworth Colliery, where George was put out as a stoker to a colliery engine, and he was often obliged to get up at 1 or 2 in the morning, and remain working in the coal pit to a late hour at night, for the magnificent remuneration of 1s. per day, but he was getting on in the world, and his great energy and manifest intelligence and perseverance were becoming observed and appreciated by his employers and fellow-workers; and afterwards, when his wages were raised to 18s. a week, he thought that his fortune was made. He now became thoroughly convinced of the great disadvantage he laid under by his want of education, and set himself, with characteristic energy, to repair the defect, which was not his own, but that of his condition in common with his father, and the occupation in which necessity had made him pass his childhood. He was 18 when he began to learn reading, writing, and arithmetic; he attended evening classes when his work was done, and every interval of leisure during the day was devoted to the acquirement of knowledge. This is the more to his credit, as our present means of self-education and elevation did not exist then. Now there are working men's institutes, libraries within the reach of all, cheap literature and lectures, easily within the grasp of the inquisitive, however poor he may be, if stimulated with the intelligence to know his ignorance, and the curiosity to acquire knowledge. All classes of society unite in urging the working classes to avail themselves of the handles of philosophy, and devote wealth and influence to that end; for the policy of the State is not to govern men through ignorance, but by their intelligence to elevate them in the social scale, subject to the same conditions under which we all live, and which no legislation can alter—that he who is intelligent, prudent, and thrifty will advance, and the idle, dissolute, and ignorant will remain poor. Your library is an evidence of this in your association; it is the laboratory, the workshop which contains the tools of self-advancement, and you have done wisely to use every effort for enlarging its usefulness.

Although Stephenson had not the command of any such library as you possess, he speedily mastered the elements of learning, and eagerly sought after all sorts of knowledge; he was sober, upright, and laborious, and respected for his worth by his companions—one named Wood instructed him in writing and numbers. He tried to improve every mechanical defect he saw, and turned his thoughts to his work and the implements of his daily vocation. In 1800 wages were low, and fame stalked in the wake of that fierce war which was then devastating Europe. The militia demanded the youthful artizans to swell their ranks, preparatory to being drilled into the line. The press-gang was eager for anyone whose gait or appearance they had any pretence to call sailor-like; substitutes could only be obtained at a price within the reach of the wealthy, and many of the working classes braved the then difficulties of a voyage to America to escape from the calamities above enumerated. At that time Stephenson contemplated going to New England, but his difficulties were so great that he did not know how that was to be accomplished. The dark cloud, however, passed away; he eluded both the press-gang and the militia, and better prospects of a livelihood arose. In 1802 he married, at the early age of 22, and in the year following his only child, Robert, was born. In 1804 he became breaksman at Killingworth, and it was whilst there that he turned his attention to tramways, and the locomotives of Trevithick and of Hedley. In 1812 Stephenson was appointed "enginewright," or, in other words, principal mechanical engineer of Killingworth Colliery, and Hedley having, as before shown, demonstrated that a rack rail was not indispensable for traction, Stephenson was authorised by his employers to construct a locomotive for this colliery. One of Stephenson's biographers asserts that "towards the end of the same year he devised and carried out his great invention of the blast-pipe, whereby the rate of combustion of the fuel, the original source of the power of the engine, is made to adjust itself to the work the engine has to perform, and is made capable, when required, of being increased to many times the rate at which fuel is burned in the furnace of a stationary engine of the same size; and in making that invention he took the step which led to the subsequent immense development of the power and speed of locomotives." But Goldsworthy claimed this invention as his, and Stephenson did not include it in his patent; but this point I must leave to the decision of those who have more experience and acquaintance with the subject than I can possibly pretend to. However this may be, whether Stephenson was the originator of the blast-pipe or not, he introduced many improvements in the mechanism of the locomotive, with which engine his name is imperishably associated. In 1823, with the assistance of the capital furnished by his friends, Edward Pease and Thomas Richardson, a locomotive engine factory was established at Newcastle-upon-Tyne; it still exists there, and is the first and oldest locomotive factory in the kingdom, and although the economy of the employment of their engines had long been established, yet the speed did not exceed that of horses, and in order to procure this speed the tubular boiler was employed. We have seen before that Watt entertained the idea of a tubular boiler, but at this time it was simultaneously and independently thought of by Booth in England, and Sequin in France; this was in 1828, at which time (see Colburn's "History of the Locomotive Engine"), and I have good authority for the assertion, Messrs. Pelletin and Delabarre, who had "re-discovered the steam jet, suggested its application, and an abundance of steam was the result." This boiler, which was converted into a tubular one, had been made by Stephenson, at his newly-established factory.

[This paper will be concluded in next week's *Mining Journal*].

The author of the paper was loudly cheered on resuming his seat, and in the brief and eulogistic discussion which followed Messrs. Tomlinson, Stabler, Tijon, Keyte, Barningham, the President, and others took part. Finally a vote of thanks, proposed by Mr. George Usher, was awarded unanimously to the talented lecturer, who gracefully acknowledged the compliment. The meeting then separated.

FACTORY SMOKE, AND HOUSE SMOKE.

Brief reference was made in the *Mining Journal* to an interesting paper read before the Social Science Congress, by Dr. CRACE-CALVERT, F.R.S., of Manchester, in which he pointed out the great difference in the deleterious effect of the smoke from factory chimneys and that from domestic fires, and it is now proposed to give a more complete abstract. Dr. Crace-Calvert explained that the action of the products of the distillation of coal upon vegetation varies a great deal, according to the circumstances under which they have been produced; thus, the products of the perfect combustion of coals may be represented by carbonic acid and water, with small quantities of nitrogen and sulphuric acid, all of which are invisible gases, having no action on vegetation, except sulphurous acid. But if coals are introduced into a gas retort and heat be applied, the products given off are enormous, chemists having already isolated and characterised more than 30 distinct substances, many of which are most destructive to both animal and vegetable life, being highly poisonous, when administered in even minute quantities; therefore, the products obtainable from coals vary enormously, according to the circumstances under which they are produced. This will enable us better to understand what is commonly called "smoke," and the reason it varies so considerably in composition. The smoke issuing from the chimneys of private dwellings may be considered, on the whole, as belonging to the class where perfect combustion occurs, for the gases, as they emerge from the chimney, carry with them only carbonic acid, carbonic oxide, and sulphuric acid, and a small quantity of the most volatile hydro-carbons which are given off, and this only takes place at the time and shortly after the coals are freshly added to the fire, the less volatile products being condensed in the flue of the chimney, forming what is called soot; but as soon as the volatile products (which are characterised by burning with flame when coals are put on the fire at first, are consumed, the carbonaceous mass which remains in the fireplace may be considered as undergoing perfect combustion, and emitting, as stated above, only gases having little or no action on vegetation or man, more especially when they become diffused in the atmosphere. But the results of burning coals under the steam boilers employed in our large factories are very different. In this case coals are constantly being added to the mass in combustion: there is not, consequently, that cessation of the distillation of tarry products above stated as taking place in the fireplaces of private dwellings, and it follows that the products of perfect combustion which are generated near the grates of the fireplaces in factory furnaces are constantly mixed with a considerable quantity of tarry substances produced by the distillation of the coals, and therefore through their imperfect combustion. In the chimneys of our dwellings the draught is such as to permit many of the imperfect products of combustion or most of the tarry products to condense, whilst in the tall chimneys erected in our factories the draught is such as to carry out from them the above noxious volatile products, and as many of them will easily condense into liquids and solids when they come into contact with a cold atmosphere, they cannot diffuse nor be carried far before they fall upon plants and other bodies existing in the neighbourhood of such chimneys, and as many of the tarry products are highly poisonous to plants they affect vegetation in a very marked manner. Black smoke, as Dr. Crace-Calvert tells us, is a mixture of the products of the imperfect combustion of coal with carbon in a high state of division; the solid particles of carbon when floating in the atmosphere become, like all solids, centres of attraction for fluids, and thereby assist in the condensation of the liquid and poisonous products above mentioned, and help to carry and fix them on the surrounding vegetation, which is characterised by a deposit of such products upon the surface of the leaves and bark of plants, and which prevents that free contact with the elements of the atmosphere which is so essential to their health and growth: for, as you are aware, plants absorb carbonic acid from the atmosphere from which their carbon is derived, and they reject oxygen and watery vapour. Further, the intensity of these actions is in exact ratio with the intensity of light, and when "black smoke" is produced in large quantities it interferes with the rays of light arriving on the surface of the earth, and thereby affects vegetation materially. In conclusion, Dr. Crace-Calvert remarked that it was most painful to reflect that, after such weighty evidence which has been adduced by many of the leading manufacturers of Manchester, such as Messrs. Bazley, J. Whitworth, Henry Houldsworth, &c., before a Committee of the House of Commons some 20 years ago, that they should still live in such a noisome, unsightly, and unwholesome atmosphere as they have in Manchester; and lastly, to witness how Acts of Parliament are put on one side, when they are to be carried and enforced by local authorities, who are in such case the offenders, and at the same time the authorities called upon to inflict fines and punishment.

Another paper, in which the views enunciated were almost directly opposed to those of Dr. Crace-Calvert, was read at the same meeting, by Mr. P. SPENCE, F.C.S., of Pendleton, who considers black smoke quite free from evil, if not a positive luxury, to those who have the privilege of breathing it. Mr. Spence denies that the black smoke of our manufacturing operations is, as one would naturally imagine from the continual outcry made against it, the worst form of the evil, or that in fact it is, all things considered, in a sanitary point of view an evil at all. If, he remarks, in getting rid of black or visible smoke, we were at the same time to get rid of the products of combustion altogether, no doubt the advantage would be great; but if in getting rid of visible smoke we only increase the quantity and intensify the power for evil of the invisible substances produced, the benefit is not apparent, and if by getting rid of visible smoke we merely get rid of a body not only inert for evil, but in other circumstances fully allowed to be a body of a health-producing character, then we not only do no good, we do positive harm. There is only one mode that seems likely to afford us just data for judging whether black smoke is unhealthful; that is, to compare towns that are in most other respects similar, and only or chiefly differ as to the existence or decree of black smoke with which they are surrounded. He takes Liverpool, Manchester, Salford, and Sheffield, which in proportion to the black smoke, should have a death rate of 44, slightly more than 44, considerably more than 44, and from 50 to 60 respectively, yet the actual numbers are—Liverpool, 44; Manchester, 33; Salford, 28; and Sheffield, 27. Thus, he maintains that the facts are decidedly in the inverse ratio of the theory of the sanitary smoke consumers, but harmonise completely with what he believes to be true theory, founded on a consideration of the nature and ordinary effects of the body with which we are dealing; and he asks—Would it not be well, therefore, for our sanitary friends to leave this matter to the economists; while we have nothing to gain on the score of health by consuming our smoke, and may have something to lose, we have much to gain in the economy of our fuel. At present we get not much, if anything, over half the available heat; and as Professor Jevons has sounded the warning note of our coal supply being limited, and as there is a probability of that limit telling at a comparatively early period upon its price, there is an increasing inducement to get perfect combustion as the chief means to get all possible economic results, but in a sanitary sense that will come soon enough. Black smoke will not be abated to any great extent till it can be done economically, and by bringing the law to your aid you only compel the manufacturer to take up the first patent nostrum that is forced upon his distracted attention, and which, as soon as your legal fangs are removed, he throws up in disgust; whereas, if you give him time, his own interest is constantly pressing him to adopt any proved means of getting all he can out of his coal, and to do this he must first get perfect combustion, and so consume his smoke, in your sense of smoke consumption, but which we are forewarned will be found to be a great increase of the smoke nuisance.

COAL IN INDIA.—The director of the Geological Survey of India, Dr. Oldham, states, in his last reports on the coal fields, that about 400,000 tons are raised annually in Eastern Bengal, while the large deposits in other parts of the empire appear to be neglected. The great beds in the valley of the Nerbudda, and in the Kurhurbari district, still lie undisturbed; but the latter will soon be traversed by a railway—a chord of the East Indian line. Another extensive deposit is the French coal field, discovered in 1852 by a missionary, the Rev. J. Hislop, in the Chenduara district of the Central Provinces, which is described as the thickest in India. Assam, too, besides its plantations of tea, abounds in coal of rich quality. Hence it is expected that, in course of years, there will be a great coal trade in India. The demand for consumption on railways must necessarily increase; and when once a steady coal traffic is established between the mines and the coast, the Peninsular and Oriental, and other trading companies, will take their supplies from thence, and save the heavy expense of sending out coal from England. Among the advantages that may naturally be anticipated will be a reduction in the cost of travelling to Indian waters, and between India and Egypt.

COAL IN LABUAN.—At the Labuan Company meeting, on Monday, Mr. Price, the managing director, stated the result of the last four months' working, of which they had received accounts under Mr. Sinclair's management. In June, the yield was 600 tons, or 200 more than under Mr. Fenwick's management. In July, the yield was 844 tons; in August, 992 tons; for September the yield was not less than 2000 tons, and it was the belief of the directors, based upon Mr. Sinclair's assurance, that before the end of the year they would reach a yield of 100 tons a day, or 30,000*l*. a year. They had a ready sale for all the coal they could raise—and, in fact, had been compelled to decline contracts with various companies, being obliged at all times to keep in store sufficient coal to supply Her Majesty's ships at a uniform rate. They had received for coal raised during the four months alluded to 3075*l*., or an average of 26s. per ton. The expenses of working, to be set against that, had been 1835*l*., or on the average 14s. 6d. per ton, and 2300*l*. had been expended on capital during the same period. Supposing the price of coal should fall 5s. per ton, they would still on a yield of 100 tons realise, after deducting expenses, a profit of 15,000*l*. a year. The extent of the petroleum springs Mr. Sinclair, whose time had been fully engaged in the development of the coal yield, had not yet had an opportunity of reporting upon. As to the production of oil from coal, the machinery for the manufacture was now arriving at Labuan, but the directors had decided upon confining their attention to utilising the waste coal in making oil, and he should add that an invention had been submitted to them for converting the refuse of the oil manufacture into a valuable kind of patent fuel. They had 300 tons of the waste coal from the present yield.—The CHAIRMAN said they had no contract with Her Majesty's Government, having declined to contract upon the conditions which the Government insisted upon, and now the Government ships called at Labuan for coal, and paid for it at the rate of a guinea per ton without any contract. While the contract existed, the Government returned coal upon their hands on the most frivolous objections; in one case the coal contained resin, which was just the thing it ought to contain—(a laugh)—and in consequence of these ridiculous objections, and the onerous

conditions exacted, the company some six months ago threw up the contract, and refused to renew it, and now they got a better price, taking all things into account, than they had done under the contract.

The Principles of the Cost-Book System Practically Considered;

EMBRACING SUGGESTIONS FOR THE FORMATION OF A COST-BOOK MINING COMPANY:

BY THOMAS TAPPING, ESQ.
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CHAPTER I.

DEFINITION AND ORIGIN OF THE COST-BOOK PRINCIPLE.

Definition.—The Cost-Book Principle is a voluntary commercial *usage*, in the nature of an ordinary common law partnership, exempted from the operation of the Companies Act, 1862, and applicable to the working of mines and other industrial undertakings, by an union or association of capital or labour, or of both. It has received the name of the *Cost-book Principle*, because all the transactions of the enterprise are entered in a *cost-book*, which is open to the free inspection of all the adventurers. The principle has *nine* essential characteristics:—

1.—That the management of the undertaking is under the control and direction of the whole body of adventurers, or their specially-appointed deputy, which deputy is in Cornish mine adventures termed *the purser*.

2.—That the powers and obligations of each adventurer, as regards his co-adventurers, are exactly commensurate with his interest in the adventure.

3.—That all questions relative to the carrying on of the adventure are, in the words of Pryce (*Mineralogia Cornubiensis*), settled not by *voices* but by *shares*, which are conclusive for the whole body.

4.—That all the transactions of the adventure are for ready money, except where a necessity, arising from circumstances or usage, otherwise requires, and all transactions are entered in a cost-book.

5.—That the costs of the adventure are paid, accounts passed, calls made, and dividends declared at meetings of the whole body of adventurers, such meetings being held on stated days, at short intervals, usually bi-monthly.

6.—That a part of the cost-book consists of a correct register of the name and address of every adventurer, and of the extent and amount of his interest in the adventure; and that such register must be kept in such a way that the fact who are or not adventurers may not only be speedily and easily known, but also may be proved by the handwriting of the adventurers respectively, or by documents under their hands, in the possession of the adventure.

7.—That each adventurer may freely transfer his shares to any person without the consent or question of his co-adventurers.

8.—That any adventurer by giving a written notice of relinquishment to the purser, and on paying his proportion of the costs of the adventure, incurred for works or for the continuation of works determined on, may at any time freely, and without the consent or question or his co-adventurers, relinquish his shares and interest in the adventure, whereupon he is entitled to valuation and payment of his fair proportion of the mine-materials, &c.

9.—That any adventurer in a cost-book mining company may transfer his shares by a notice to the purser, bearing a sixpenny stamp, whereby the adventurer is relieved from the formal and expensive instrument known in joint-stock companies as a *share transfer*.

Although the forfeiture of shares upon non-payment of calls is a well-recognised customary principle in all mine adventures, as in Derbyshire and other mineral districts of England, yet, owing to insufficient proof of the usage, in the case of *Hart v. Clarke*, determined by the House of Lords, that Supreme Court ruled that the forfeiture of shares for non-payment of calls is not an inherent part of the Cost-book System of Cornwall, and that in order to clothe co-adventurers with such a power it is necessary that they pass a rule conferring such power, and insert it in the cost-book. This ruling is certainly contrary to Cornish notions and mining custom, but, perhaps, as the power to forfeit is a highly penal one, and may be, and often is, abused, it is as well that the House of Lords has ruled as it has done. At all events, adventurers respect the ruling, and usually, since that decision, agree to such a rule when it is intended to confer the power to forfeit.

Cost-book companies may be formed for carrying on any lawful enterprise in any part of the United Kingdom; but when any cost-book company is not formed for the purpose of working mines, subject to the Stannaries, within the counties of Devon and Cornwall, and consists of *less* than 20 persons, it is purely and simply a common law partnership, uncontrolled by the customs either of Cornwall or of Devon, and not subject to the Stannary jurisdiction, and, therefore, all partnership disputes between the partners are cognizable by the High Court of Chancery, and by no other Court. It may be here observed that if such a cost-book company, not being for the lastly above-mentioned purposes, consists of *more than twenty persons*, it must, to render it legal, be registered as a joint-stock company, under the "Companies Act, 1862."

Origin.—It is now nearly 20 years since the Cost-book Principle was first recognised by London capitalists as being well adapted to the financial management of industrial undertakings, particularly of mines, on simple, safe, riskless, economic, and equitable principles.

Our readers are probably aware that the Cost-book Principle has been known and worked in Cornwall for so long a period of time that its commencement is unknown. Ancient county history and writers notice it, but none state its origin. It is, therefore, reasonable to presume that the principle was coeval with the first working of Cornish mines in partnership—that is, by the union of the labour or capital, or of both, of two or more persons.

It is due to, and may be a satisfaction to the *Mining Journal*, to here state that it is very doubtful whether the Cost-book Principle would have been understood in London, even at this day, except for the able advocacy it has received in the columns of that leading and ably-conducted periodical. To its teachings and exertions are London capitalists mainly indebted for the clear understanding of one of the most useful and equitable principles that has ever been applied to industrial enterprise, and particularly to mining adventure.

CHAPTER II.

HOW TO FORM A COST-BOOK COMPANY.

In considering the steps necessary to be taken in order to adopt the above principle as the legal basis of an industrial undertaking, it will be convenient to consider a mine or mining adventure as the enterprise to the regulation of which it is proposed to apply it. The first step is to conditionally negotiate for the intended sett. If the ground be *virgin ground* it is usual to obtain from the lord of the soil a *take-note*, or *tack-note*, which is nothing more than a licence from such lord to the miner enabling him to search and explore the ground for two or three years, by costeaning, shoding, streaming, &c., with the stipulation that if the miner require it he may, at his sole option, call for a lease of the ground for an agreed term, and on the payment of agreed royalties. Take-notes are usually prepared in the rough, but adventurers should do well to have the terms and language of the take-note approved of by a competent lawyer. The cost is small, the protection and advantage very great. If the ground be *proved ground*, or the indications be so favourable as not to to render it prudent for a *take-note*, such preliminary document is, of course, dispensed with.

When it is arranged to negociate for a sett it will be found most material for the adventurers to insist that the term be long, and that the dues or royalties be easy; for it must be remembered that not only is mining a very hazardous, but that it is also a very time-taking and money-absorbing enterprise. Our strong advice, founded on long experience, expressed as well in the interest of the lords as of the miners, therefore is, that as a general rule no sett ought to be for less than from 30 to 40 years, nor the dues more than the 1-21st part. The usual rates in Cornwall are, term 21 years, and dues from 1-15th to 1-21st; in Derbyshire and Shropshire, term, 21 years, and dues 1-15th to 1-12th. In Wales the lords attempt shorter terms and higher dues, but all this is little less than rapacity and covetousness on the part of lords, which, for the most part, is injurious both to the lord and the adventurers. The loss to the lord is by having his mine "knocked" and discredited, and the loss to the adventurers is the being obliged to abandon their enterprise and to lose their outlay before they have cut *riches*. The agents of many lords attempt to meet the above reasoning by alleging that if the mine be unsuccessful questions as to length of term and amount of dues are of no moment; and that if the mine is successful the riches obtained usually render the terms light; and, further, that the sett can always be renewed. But such statements are, at most, but plausible answers, for few new mines can be developed in less than seven years, during all which time heavy *dead work* must be done, and which must be paid for, if at all, after the first seven years, and before the end of the term; and, further, every sharedealer and mine capitalist, before buying, enquires the length of term and amount of dues, and usually refuses to give so much for a share in a mine which has but a dozen years or so to run as in one whose sett will not expire for 20 years. As to the suggested renewal, that may be completely answered, or rather silenced, by a reference to the well-known case of a Cornwall Duchy lease which Prince Albert refused to renew, except upon the payment of an exorbitant fine, which, if the facts be remembered rightly, was rejected by the adventurers, who in disgust gave up their mine after an expenditure of about 20,000*l*. As a general rule, if a mine is a success a renewal cannot be obtained from the lord without a premium paid to him in one shape or another. This should never be forgotten. Again, as the expiration of the sett approaches the working of the mine is always altered, and its adventurers never, if they can avoid it, allow others to reap what they have sown, and, therefore, usually "pick out the eyes" of the mine, to the ruin of succeeding adventurers, and to the disadvantage of the lord. Further, the approaching expiry of a sett is always a continuous subject for anxiety, thought, and irritation on the part of the adventurers, and always leads to a change of management. In conclusion, it may be asked why it is that if a capitalist proposes to lay out money in improving the *surface* the lord will grant him a 99 years' lease, at a moderate—almost nominal—ground rent; but that if he proposes to lay out money *underground*, in developing its riches in a hazardous and expensive enterprise, the lord usually stipulates, not only for a 21 years' lease, but also for the 1-15th or the 1-12th *of the gross returns*. The answer to the above question is that in the former case the terms are fair and reasonable, and that in the latter case they are extremely unfair and grossly unreasonable. Rest assured that many of the mining failures which from time to time shock mining enterprise and ruin adventurers are traceable either directly or indirectly to the above two sources—that is, first, short terms for years; and, secondly, high dues. Therefore, the sooner the miner is dealt with more reasonably the better for the lords.

Assuming the terms for the sett are arranged, the lord usually refuses to grant except to one or two responsible lessees, men upon whom he can depend, and whom he can make answerable for any non-fulfilment of the terms of the lease. The position of lessee in a mining sett is, therefore, a dangerous and onerous one, and should be dealt with in this way:—First, the lessees should, by an express resolution passed by the adventurers, be indemnified from possible loss or damage as such lessees;—and, secondly, the lessees should, by declaration of trust, or by some other instrument in writing, declare that they hold the sett in trust for, and for the benefit of, the adventure, and thus not only protect the adventurers but themselves also in equity. It is almost unnecessary to state that neither such indemnity, nor the declaration of trust, can with safety be dispensed with, and that their preparation should be confided to competent legal advisers.

So soon as the take-note, sett, and lessees have been conditionally arranged for, the leading adventurer usually summons his friends to a meeting, at which he lays before them his suggestions for an adventure, explains the nature of the country-rock, details the number, sizes, courses, hadings, &c., of the lodes that traverse the sett, and usually shows the specimens he has broken with his own hands. The sett is usually visited, and we will assume that some, at least, of those present at the meeting agree to join the adventure.

The consenting parties meet on a subsequent occasion, to conditionally appoint a purser, and consider the rules and regulations by which the adventure is to be governed. They also agree upon the capital and number of shares, a subject which is discussed hereafter. The rules they for the most part adopt from those of other neighbouring mines,* or draw them up in accordance with the resolutions of the meeting. After the meeting has settled what the rules shall contain, it would be prudent to submit them to some competent lawyer, to ensure not only that their language is legally as well as grammatically correct, but also to suggest any material amendment, which the constantly changing course of the law may render advisable. It should not be forgotten, that as the rules form the foundation and constitution of the adventure, so they should be intelligible and legally sufficient, and that no expense or trouble should be spared to make them so.

The adventurers having privately, as it were, agreed upon their rules, the purser should be directed to obtain a cost-book, and to call the first adventurers' meeting. At this meeting the advanturers usually discuss the captain's and engineer's reports, also by resolution approve of the rules as settled by the legal adviser, and resolve as follows:—

1.—That this adventure shall be conducted according to the Cost-book Principle, as recognised in the counties of Cornwall and Devon, subject to the rules and regulations from time to time passed and entered in the cost-book.

2.—That the book now produced and signed by adventurers be the cost-book of the adventure.

3.—That the purser do, and he is hereby directed to, enter in such cost-book the rules upon which it has been at this meeting agreed that this adventure shall be governed, and to authenticate them by impressing them with the company's seal.

4.—That it shall be the duty of the purser to keep the cost-book, and all entries therein, in a fair and intelligible manner.

5.—That the captain's and engineer's reports be read and entered in the cost-book.

6.—That the affairs and business of this adventure shall be carried on and transacted by A. B., C. D., E. F., &c., who are hereby appointed the directors of this adventure.

The above are the usual resolutions, but any others may be added which the requirements of the adventure may render necessary; such as the appointment of the merchants, principal officers, bankers, solicitors, &c. The adventure having assumed a legal and commercial position, proceeds with its adventure in the ordinary course, care being taken that every transaction of the slightest moment be duly resolved upon and recorded in the cost-book.

CHAPTER III.

CAPITAL AND SHARES.

The amount of the company's capital is for the most part suggested by the captains' and engineers' reports. Formerly, at whatever sum such capital might be fixed, it was the invariable practice in Cornwall to divide the mine or adventure into 1024 parts or shares. Whether the capital required was 100*l*. or 100,000*l*., still no capital was suggested, but the mine was always divided into the stereotyped 1024 parts or shares. It was, however, seldom that each adventurer took but one share only, for many went in for an eighth=128 parts, others for a sixteenth=64, and so on, so that the number of adventurers was usually few. But lately the joint-stock principle has been introduced, and the capital of cost-book *companies is now ordinarily expressed*—that is, the adventure is divided into a recognised number of shares of a *determinate amount*. Thus, assuming the capital to be 100,000*l*., it is usually divided into 10,000 shares, of 10*l*. each. Thus the cost-book principle is the division of the *mine* or adventure into indeterminate parts, and the joint-stock principle is the division of the capital into shares of determinate amount. Perhaps, as the latter principle limits the extent of calls to the nominal amount of the share, it is an improvement upon the Cost-book Principle.

* See a form of rules in Tapping's "Prize Cost-book Essay," p. 69. Published at the *Mining Journal* Office, 26, Fleet-street, London.

As all the adventurers are partners, they cannot sue each other at law for non-payment of calls. If the enterprise is in Cornwall or Devon, a suit in the Stannary Court lies for contribution, and a similar bill in Equity might be successfully maintained. But, practically, there is no legal method for compelling the payment of calls. This disability has given rise to a much-abused course, of causing one or more of the creditors of the concern to sue the defaulting adventurers, and thus indirectly to obtain from him an amount equal to his calls. In return, a determined adventurer, when sued by such a creditor, oftentimes files an injunction bill against the plaintiff-creditor and the company, alleging that such plaintiff is suing for the company only, and not upon his own behalf. If the adventurer proves his case, the Court generally stops the action upon equitable terms.

A person becomes an adventurer in a cost-book company either by signing the cost-book for the interest he takes, or by giving the purser notice of his taking, and by authorising such officer to sign the book on his behalf. When once an adventurer, he becomes clothed with all the rights and liabilities detailed in, or arising out of, the rules and regulations and legal status of his company. As regards creditors, he is liable to pay all the debts of his company, properly and legally contracted; and although he may relinquish his shares, yet he is liable to fulfil all the engagements of the company duly contracted whilst he was such partner, and before such relinquishment.

A valuable and distinctive feature of the Cost-book System is, that any adventurer may freely, and at any time, dispose of his interest to any person without the consent of his co-adventurers. Thus, he may introduce a new partner without consent; he has, as the lawyers term it, a *delectus personæ*, which allows him an easy, speedy, and secure method of getting out of a concern with which he does not care to be longer associated.

One of the main peculiarities of the Cost-book Principle is the extremely simple and easy means it affords for the transfer of shares. Indeed, the usual and necessary mode by which shares in such associations are transferred is not by an ordinary instrument of transfer, but by a mere written notice, directed to the purser, informing him that the adventurer has transferred his shares to a person named in the notice, and requesting the purser to enter the name of the transferee in the cost-book as the owner of such shares. Such notice also usually contains an acceptance of the shares by the transferee.

In a recent case the form of transfer was as follows:—

To Mr. J—— B——, purser of the —— Mine.

Sir,—I, A. B., of ——, hereby request you to enter on the cost-book a transfer by me of 100-1024th parts or shares in the —— Mine, to C. D., of ——, who is now the owner of such shares, and holds the same, together with all the benefit, profits, and advantages thenceforth to arise therefrom.—Dated, &c. A. B.

I, the above-mentioned C. D., of ——, hereby beg to inform you that I am the above-mentioned transferee of the said shares, and that I have accepted, and now hold, the same, subject to the same rules, conditions, and regulations as those under which the said A. B. held the said shares, and hereoy authorise you to enter my name on the cost-book in respect thereof.—Dated, &c. C. D.
Witness ——.

By cost-book law such substitution of name is sufficient proof of ownership as well as against the transferor, also against all the world, creditors included. By a recent statute the Legislature has directly recognised such notice as equivalent to a transfer of shares by subjecting it to a duty of *sixpence:* and by directing that the person who writes or signs any such notice must affix an adhesive stamp thereto to denote such stamp duty, and should cancel and obliterate the same by writing on it his name, or the name of his firm or principal, or the initials thereof, and the date of the day and year on which he so writes the same.

It is the duty of the transferee to transmit the above notice to the purser for registration, and so soon as the purser receives it it becomes his duty to register such transfer, and this he should do by substituting in the cost-book the transferee's name for that of the transferor as the holder of the shares transferred. It is also the duty of the purser to certify to both the transferor and transferee that he has so made the requested transfer.

Perhaps the most important result of a neglect either on the part of the transferee to obtain, or on the part of the purser to make, such transfer is that so long as it remains unregistered the transferor remains the adventurer in respect of such shares, and consequently continues liable for all future calls; and also if the shares are not of a determinate amount, the transferor also remains liable for the debts of the adventure.

As a caution to transferees and to pursers, it may be here observed that if the latter neglects to give notice of the transfer to the purser, he, the transferee, is liable to an action at the suit of the transferor for such neglect of duty; and that if the purser, having received due notice of the transfer, neglects to register, and calls are made upon, or any other damages accrues to, the transferee by reason of such want of registration, he (the purser) is liable to an action at the suit of the transferor for compensation in damages.

CHAPTER IV.

1. INSPECTION OF MINE.—2. THE JURISDICTION OF THE STANNARY COURTS.

1. *Inspection of Mine.*—Every adventurer of a cost-book mine has, it seems, a right to inspect it at all convenient days and times, so that the workings and transactions of the mine are not impeded by such inspection. So universally is this right recognised that most Cornish mines set apart a day, usually one day a month, called the *inspection* day, for that purpose. On this day all captains, engineers, and others commissioned to inspect and report on the mine by adventurers and others must attend and make their inspection, otherwise they must await another opportunity. If, however, such inspection is not *bona fide*, but made in order to supply information to sharebrokers, dealers, &c., for market purposes, it may be properly refused by the purser. In a recent case it appeared that an adventurer, having stated to the purser his intention to inspect the mine on two specified days, was refused inspection on those days, whereupon the adventurer applied to the Stannary Court for an order to inspect the mine on some day to be named by the Court, but the Court, after hearing all parties, refused the application, on two grounds—firstly, that the applicant had not been wholly prevented from making such inspection, as a day had been named upon which he would have been allowed to inspect, although such day was not one of those specified by the applicant; and, secondly, because such inspection was regulated by the company's rules, and the applicant's request was not in accordance with such rules. At the same time, the Court stated that if the managers had attempted to exclude all access to the works by other adventurers, or had arbitrarily forbidden the admission of certain adventurers, there might have been just reason for complaint. But as nothing of the kind was imputed to them, the Court dismissed the application, with costs.

2. *The Jurisdiction of the Stannary Courts.*—The Stannary Courts of Cornwall and Devon have a legal and equitable jurisdiction, based on custom and amplified by statutes, over certain mining matters arising within those counties, and amongst them is undoubtedly to be ranked the transactions of cost-book mines; indeed, the main part of the business of the Equity side of the Court consists of proceedings to enforce its usages and customs, and to wind-up such companies. For instance, the purser of a cost-book mine is enabled by Stannary laws to sue, by petition to the Vice-Warden, any adventurer, whether resident in or out of Cornwall, for his proportion of the mine costs, audited and signed by the adventurers in meeting assembled. This petition, when the defaulter resides within the Court's jurisdiction, is served on him personally, and when he resides out of the jurisdiction the service is effected by affixing copies of the petition, and the summons which accompanies it, to the door of the account-house, or other conspicuous place on the mine. As to the jurisdiction of the Stannary Court in winding-up cases, see the next chapter.

It should not be forgotten that the Companies Act, 1862, extends the jurisdiction of the Stannaries over all joint-stock companies engaged in working mines within and subject to the jurisdiction of the Stannaries.

CHAPTER V.

ON THE WINDING-UP OF COST-BOOK COMPANIES.

The Court by which a cost-book company is to be wound-up depends upon the objects of the company:—1. If the company be for working mines within, and subject to, the jurisdiction of the Stan-

naries, then in such a case the Court of the Vice-Warden is the proper Court to wind it up, unless the Vice-Warden certifies that, in his opinion, the company would be more advantageously wound-up in the High Court of Chancery. The Vice-Warden may direct that a winding-up petition shall be heard by him at such time, and at such place within the jurisdiction of the Stannaries, or within or near to the place where the company's registered office is situate, as he may deem to be convenient to the parties concerned, or with the consent of all such parties, at any place in England. There is the ordinary appeal and re-hearing from the Vice-Warden, or the Lord Warden may at once remit the appeal to the High Court of Chancery.

2.—If the company be composed of less than 20 persons, and be not formed for the purpose of working mines within, and subject to, the Stannaries jurisdiction, in such case the High Court of Chancery is the jurisdiction, having power to wind it up.

CHAPTER VI.

ON THE REGISTRATION OF A COST-BOOK COMPANY AS A JOINT-STOCK COMPANY.

The Companies Act, 1862, expressly declares that a company engaged in working mines within, and subject to, the jurisdiction of the Stannaries, and consisting of seven or more members, may at any time register itself under such Act as an unlimited company, or a company limited either by shares or by guarantee, and no such registration is invalid because it has taken place with a view to the company being wound-up. In order to so register an assent must be given by a majority of such of its members as may be present, personally or by proxy, in cases where proxies are allowed by the regulations of the company, at some general meeting summoned for the purpose. In order that a cost-book company be registered as a limited or guarantee company, certain other formalities are required, for which the reader is referred to the above-mentioned Act.

In conclusion, it may, without derogating from the value of the Cost-book System, be stated that the Joint-Stock Principle is fast supplanting the former system on its own ground—that is, in the counties of Cornwall and Devon. On the one hand, the Joint-Stock Principle admits of limited liability—a very great advantage,—but it is cumbrous in its machinery. On the other hand, the Cost-book System does not provide for limited liability, but it is far more economic and manageable for the working of mines and other enterprises, where there are few partners, and the capital is moderately large. The great desideratum, therefore, would be an Act of Parliament allowing cost-book mines to protect themselves with limited liability on registration, but without being subject to the cumbrous machinery of the Joint-Stock Acts. Some day this boon may be conceded to mining enterprise: if so, the time-honoured Cost-book Principle will retain, as it deserves to do, its first place as a constitution for industrial undertakings, particularly of mine adventures.

MANUFACTURE OF GUN-COTTON.

There is, perhaps, nothing which has so much impeded the general introduction of gun-cotton as a substitute for gunpowder as the difficulty of regulating the rate of explosion, which is frequently so rapid as to render the substance almost beyond control. It appears that Mr. E. C. PRENTICE, of Stowmarket, has now succeeded in completely removing the difficulty; he has patented an invention which consists in interweaving other cotton or suitable fibrous material in an inert state with gun-cotton, to retard and modify the rapidity of its explosion to such an extent as may be desired for the special purposes to which the explosive compounds are to be applied. Mr. Prentice has ascertained in practice that it is desirable to employ as little inert cotton or other fibrous material as may be, in order to obtain the desired degree of retardation in the burning of the pyroxylin, more particularly when the compounds are to be used in fire-arms, as the use of comparatively large proportions of the inert or unconverted cotton or other fibre tends to foul the barrels, and he has further ascertained that the points of contact and intersection of the converted fibre with the unconverted fibre should be as numerous as possible, and that the more minutely the fibres are divided, and the more intimately they are interspersed amongst each other, the less proportion or quantity of the inert or unconverted cotton or other fibre is required to produce a given retardation in the burning of the pyroxylin, consequently there should be no massing or accumulating of the converted fibre (pyroxylin), or of the unconverted cotton or fibre, but, on the contrary, as intimate a mixture of the two classes of fibres as possible.

In some cases Mr. Prentice employs rovings or yarn, the cotton or fibre of which has been converted by acid into pyroxylin, as is well understood, before and after being formed into rovings or yarn, but he makes no claim to the manufacture of rovings or yarns of gun-cotton or other converted fibres when separate and apart from their use in combination with inert or unconverted cotton of other fibres as a means of retarding the speed of the burning of the yarns or rovings of gun-cotton or converted fibre. He interlaces them together by any suitable weaving machinery. The proportion in which inert or unconverted cotton or other fibres may be combined with gun-cotton or pyroxylin may be greatly varied, depending on the extent to which the quick-burning properties of the pyroxylin or converted fibre is desired to be retarded by such admixture; but he has found it desirable, more particularly when the manufacture is for large or small arms, not to employ more than 30 per cent. of the inert cotton or fibre with 70 per cent. of pyroxylin or converted fibre, when such fibres are respectively made separately into rovings or yarns and are woven or interlaced into fabrics, as above described, and when the interspersion of the converted and unconverted fibres are still more intimate—as is the case in pulping the fibres and making paper or paper stuff of mixtures thereof. He has found that for sporting purposes about 15 per cent. of the unconverted with 85 per cent. of the converted fibre makes excellent paper, and that about 30 grains by weight of such paper rolled into a cylinder makes a proper and sufficient charge when used with about 1 oz. by weight of shot. Mr. Prentice's claim is for the combination of converted cotton or fibre (pyroxylin) with unconverted or inert cotton or fibre, both being in the state of rovings or yarns, by weaving or interlacing thereof into fabrics, as above described; he also claims the cutting such mixed rovings or yarns into short lengths and composing charges thereof; the mixing converted and unconverted cotton or fibres in the desired proportions, and then forming rovings or spinnings, as above described; and the making of paper or paper stuff, or material of mixtures or combinations of converted fibres (pyroxylin) and inert fibre.

PEAT AS SMELTING FUEL.—An experiment for testing the value of peat as a smelting fuel has been made at the Caledonia Ironworks, Montreal. The test was a severe one, and completely successful. A cupola was filled with ore, part mixed with coal and the remainder with peat. The usual proportion of coal to the ore is one to seven, and two-thirds of the cupola was filled in the usual manner, the remaining third being occupied with peat and ore in the proportion of one of peat to twelve of ore. The metal was ready for the mould in 40 minutes less than the ordinary time required when coal is used, and the iron produced by the peat was of a better quality than the other. Mr. McDougall, of the Caledonia Ironworks, Mr. Watson, President of the Canada Iron Smelting Company, Mr. Shanly, and Mr. Eaton, superintendent of the Grand Trunk Locomotive Department, are said to have all concurred in the opinion as to the superior quality of the peat-smelted iron. It is claimed that it is both more compact and more tenacious than ordinary iron. Should future experiments establish the correctness of these views, a new impetus will be given to the industry of the province. The deposits of iron ore are abundant, and if peat can be utilised for smelting it, the mineral resources of the country will be more rapidly developed than they have been in years past.

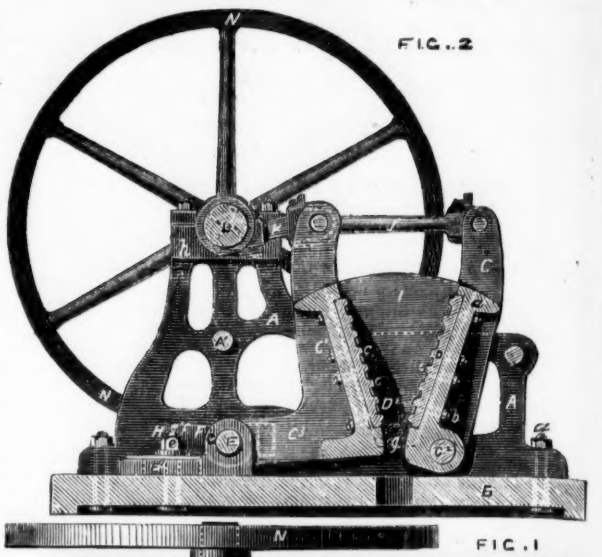
TREATING SLAG.—According to the invention of Mr. J. J. BODMER, of Newport, Monmouthshire, it is proposed to cause the cinder or slag to run direct from the furnace upon a pair of rolls, revolving at a surface velocity corresponding more or less with the flow of the cinder or slag. The slag issues from the rolls in the shape of scale, which is allowed to drop on and to be conveyed away by a carrier belt or other apparatus; or a stationary box or cistern filled with water may be placed under the rolls, the rolled slag dropping on a carrier belt, which passes through the water; or the receiver or truck may be filled with water, the rolled slag falling into the water, which is thereby caused to overflow as the truck fills with slag or cinder. When filled the truck is withdrawn, and replaced by a fresh one. In order to keep the rolls cool a stream of water may be allowed to flow upon them, or they may dip into water troughs provided for this purpose. Instead of treating the slag or cinder directly as it flows from the furnace in which it is first produced, he also re-melts the various kinds of slag or cinder from tips and other accumulations, and passes it through rolls. The rolls may be set closer to or further apart from each other within certain limits, according to the object in view, and instead of causing the rolls to revolve at the same surface velocity one roll may revolve quicker than the other, and thereby produce a grinding action in addition to or instead of a simply laminating action. After having passed through this apparatus the cinder or slag may, if necessary, be conveyed to other grinding apparatus. Instead of a pair or pairs of rolls one roller, acting against a fixed plane or a curved surface, may be employed. Slag or cinder treated as described is applicable for making mortar, for the manufacture of artificial stone and of cements, for manure, and a variety of purposes.

NEW ALLOY.—M. H. Micolon, of Paris, proposes a new alloy for the manufacture of bells, hammers, non-cutting tools, &c. It consists of 20 parts of iron turnings or tin-waste, 80 parts of steel, 4 parts of manganese, and 4 parts of borax; but these proportions may be varied. When it is desired to increase the tenacity of the alloy, two or three parts of wolfram are added. When the cupola is ready the iron and steel are poured in, the manganese and borax, and the vessel filled with coke.

A NEW MAGNET, of considerable power, has been introduced by M. Greiss, consisting of a long spiral iron or steel film, such as is obtained from iron-turning. According to M. Greiss, the south pole of such a magnet is always at that end of the spiral which the instrument has first touched. He also states that the magnetism of these spirals is of a very permanent nature.

IMPROVEMENTS IN PULVERISING ORES.

Some improvements in machinery for crushing, grinding, and pulverising metallic ores, quartz, stones, coal, bones, and other hard substances, have been patented by Mr. JAMES JONES, of Southampton-buildings, Chancery-lane, mining engineer. They consist chiefly in the means for adjusting the jaws and side-plates between which the ores or other substances are crushed, in the mode of operating the jaws, and also in the mode of constructing the beaters (for pulverising), and the case in which the beaters are enclosed. Fig. 1 of the annexed engraving is a plan of the top of the crushing jaws and parts connected therewith. Fig. 2 represents a section on the line *x x*, Fig. 1. The framing A, which is constructed to support firmly and conveniently the working parts of the machine, is securely attached to the foundation-plate B by the bolts *a*, the two sides of the said framing being strongly braced together by the cross-ties or stays A^1. The crushing jaws, between which and by whose action the ores or other substances are broken or crushed, consist of strong plates of cast iron C and C^1, lined on their contiguous surfaces with other plates of chilled iron D. These plates D are made in two or more sections, secured upon the plates C and C^1 by the bolts *b*, the heads of which are recessed or countersunk, as represented in Fig. 2. The plates D are furnished with teeth *c*, but may be advantageously formed with ribs or corrugations, or may even be quite smooth on their surfaces. The jaw C is provided with the pins or studs C^2, which are supported so as to vibrate freely in the bearing *d*, secured in the sides of the framing A. The other jaw is provided with an arm C^3, by which it is attached to a vibrating shaft E, working in the adjustable bearings F and G. By the employment of these adjustable bearings for supporting the jaw C^1, the jaw can be set nearer to or farther from the other jaw C, and the ores or other substances placed between the jaws can be thereby crushed more or less finely, as required.



The central bearing G, through which the shaft E passes, is formed with a base or foot E^1, resting upon the foundation plate B. The base is provided with a slot or aperture *e*, through which is passed the bolt e^1. The slot *e* allows the bearing G to be easily moved and secured in any required position on the foundation plate B, which materially assists in the adjustment of the jaw C^1, and also serves to keep the jaw C^1 from being drawn closer to the jaw C. The end bearings F of the shaft E are fitted to slide in the horizontal guideways H formed in the sides of the framing A. When the crushing jaw C^1 has been correctly adjusted, the nut e^2 is screwed down tightly, to prevent the moving of the bearing G, whilst the blocks *f* are inserted in the guideways H behind the bearings F. These blocks, which may be of any required thickness, prevent the jaw C^1 being forced back out of its position when operating upon the ore or other hard substance being crushed. Instead of the blocks *f*, screws passing through the back of the slots H may be employed to adjust and secure the bearings F. The side plates I prevent the escape of the ores or other substances from the sides of the crushing jaws C and C^1. These side plates are fitted accurately and closely to the edges of the jaws, and are adjusted and secured in contact therewith by the screws *g*, or other suitable means. The sides of the chilled iron plates D are formed with projections D', to afford a greater bearing surface against the surface of the side plates I. The jaws C and C^1 receive a powerful vibratory motion from the cranks L^1 and L^2 on the crank shaft L, the jaws and cranks being connected together by strong rods J and K. The cranks are formed by turning down portions of the solid shaft L till the proper diameter and throw for each crank is obtained. The two side cranks L^1 are formed on the shaft L, exactly opposite the central crank L^2. The cranks L^1 operate the jaw C, and the crank L^2 operates the jaw C^1, as shown in Fig. 1. By this arrangement of the three cranks L^1 L^1 and L^2 the two jaws C and C^1 are caused to operate together with a very strong pressure upon the ore or other substance placed between them. The foundation plate B is provided with the apertures *i*, through which the particles of ore or other substance pass after being crushed. Motion is communicated to the shaft L by a driving belt passing over the pulley M, and this motion is equalised by the fly-wheel N firmly keyed on the end of the said shaft; or two driving pulleys may be provided, fixed one on each end of the shaft L, instead of one pulley and a fly-wheel.—*Mechanics' Magazine.*

THE EFFECT OF LIMITED LIABILITY PARTNERSHIP ON THE PROGRESS OF ARTS, MANUFACTURES, AND COMMERCE.—Mr. W. Hawes read a paper on this subject at the Society of Arts, in which he described fully the forms of partnership, past and present, in use amongst our commercial classes, and while explaining their principles said that he, in common with many others, thought that the laws governing the relations between trade debtors and creditors had been prejudicially interfered with by recent legislation. The paper warmly urged the advantages to be derived from participation by workmen in the profits of trading concerns, declaring that the injurious restrictions imposed by trades' unions would thereby be removed. The chief conclusions arrived at were, that notwithstanding the losses, bad management, and disappointment characterising many joint-stock enterprises since the Act of 1862, there was no reason to doubt the soundness of the limited liability principle; that the object to be kept in view by all who joined limited liability companies was to see their liability was limited, either to the cash advanced, or to such further payments or calls as they could conveniently make if called upon in a short period; and that, if by affording facilities for the establishment of co-partnerships in industry, or the appropriation of a percentage of profits in ordinary partnerships to all engaged in them, greater results could be obtained than by the old plan, that system of legislation by which such a change in the relations of capital and labour could be brought about would rank foremost amongst those means to which we should be indebted for the future prosperity of our arts, manufactures, and commerce. A spirited discussion followed, the speakers including M. Gerstenberg, Mr. Sydney, Dr. Pankhurst, Mr. Moxon, Mr. Field, Captain Selwyn, and others. One of the speakers stated he knew a gentleman who was a director of 20 companies, receiving about 6000*l.* as direct remuneration, and some 15,000*l.* more from speculations rendered successful from the special knowledge he had gained at the various boards of directors.

NITRO-GLYCERINE.—In continuation of his letter, published in the Supplement to the *Mining Journal* of November 10, Col. Tal. P. Shaffner writes:—

When I visited the Hoosac Tunnel in August I had not witnessed the explosion of nitro-glycerine in rock of the hardness of the Hoosac Mountain. The tunnel is penetrating through solid massed mica and quartz. The strata lie against the progress, and there are but few seams and slips. It tears roughly, and in no instance quarries. Every cubic inch must be blasted. The heading is 6 ft. high and 15 ft. wide. Below is the bench or bottom enlargement, 4½ ft. deep, the width of the heading. In the west shaft it is about 300 ft. in the rear of the heading. The further enlargements are to be above and at the sides. My experiments were in the west shaft, bench, and heading, proceeding eastward. Prior to my arrival, good miners have been making from 2 to 3 ft. per day with the bench. The holes had been set from 15 to 20 in. back, drilling four holes to make the width of the tunnel. These four holes were drilled 4 ft. deep, charged with powder, and well tamped. After blasting the four holes, about five short holes, averaging 15 in., had to be drilled, in order to make an even bottom. According to these figures, the number of inches to be drilled to make 60 7-10ths feet lineal would be 96:2. Two men can drill about 100 in. per day of eight hours, and wages are $2·25 per day. The expense for miners' tools and incidentals amounts to about $6 per eight hours for each 100 in., making a total of $566·72 for drilling. The time required to make 60 7-10ths would be at least 20 days. There be about 144 long holes, 180 short holes, and at least 36 blasts. This is the rate of progress that had been made with gunpowder.

My firs texperiment was in the "bench," as above described, and within three days I advanced 60 7-10ths feet. I used nitro-glycerine, exploded by the aid of electricity. If the rock could be removed after each blast, I can make 70 ft. in that time. I had nine blasts and 28 holes, 5 ft. deep; total inches drilled, 1680. The cost of the nitro-glycerine was less than the price of gunpowder for the same number of feet. My next experiment was in the "heading," for a period of three days. The average speed per month with powder had been 64 ft., blasting every two hours holes 20 to 30 in. deep. When I commenced my experiment the rock was excessively hard, and the trial was very severe against me. I blasted 15 holes every eight hours; holes from 30 to 36 in. deep. Within the three days I made 14½ ft. The next three days the rock happened to be better for blasting, and powder was used, making 6 4-10ths feet. Number of nitro-glycerine holes, 132, and about 4356 in. for the 14½ ft. Number of powder holes, 180, and about 4500 in. drilling, making 6 4-10ths feet. In the same class of rock I am of opinion that I can make at least 35 ft. per week in the heading, and in a month of 27 days about 158 ft., making 94 ft. per month more than can be accomplished with gunpowder. From these figures the Hoosac Tunnel can be finished in less than half the time, and for less than half the expense, by using nitro-glycerine. From eight to ten years has been the estimated time for completing the work, and the expense, several millions of dollars. For these economic considerations the very able chief engineer of that great enterprise is encouraged to believe in the early completion of the work by his adopting nitro-glycerine. Before closing my letter I wish to give a warning to the Nitro-Glycerine Company. It has the patented monopoly for its use for 17 years, and an evasion of the patent is not possible. To attain great success large sales and small profits is mercantile practice. It is to be hoped that their present price, $1·75 per lb., will not be increased. I refer to this because the company has, through its board of directors, on account of the great demand for nitro-glycerine, passed a resolution not to sell any more of the construction stock for a sum less than par. In my next I will give more important information in regard to charging and tamping nitro-glycerine blasts.—*Scientific American.*

The Admiralty have ordered Messrs. John Brown and the Messrs. Charles Cammell each to manufacture one large iron plate, of a special and harder nature than is usually observed in the making of armour-plates, with a view of testing a theory of the possibility of breaking up these chilled projectiles, such as the "Palliser," before they can effect penetration of a plate. This will be a difficult problem for the Messrs. Cammells and Messrs. J. Brown to solve, and especially so if they are to make the attempt with hard iron plates only. All our past experience goes to prove that hard-made armour-plating is the more easily destroyable of any, and even with ordinary cast-iron shot each single blow will star it with deep fissures in a startling manner. The Admiralty have, however, put a premium upon the skill and judgment of the two firms named, and there can be no doubt they will each do their utmost to excel all their former work of the kind on the present occasion. The War Office has intrusted to the Messrs. Cammel the contract for the manufacture of 20 iron shields for the embrasures on the sea-face of the fortifications at Malta and Gibraltar.

Two years ago an attempt was made to construct a mineral railway into London, but the Act was crushed by the combined efforts of the great railway companies. The Derbyshire coalowners have now received a circular from the railway companies, informing them that the rates for coal in owners' wagons to all the London and North-Western, North London, Midland, Great Western, Great Northern, and Great Eastern Railway stations are advanced 6d. per ton. These gigantic combinations are unjust, and injurious to the public interest, and tend to prevent the development of the industry and resources of the country.

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